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SYSTEMATICS OF SOUTHERN BANNER-TAILED KANGAROO RATS OF THE *DIPODOMYS PHILLIPSII* GROUP

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SYSTEMATICS OF SOUTHERN BANNER-TAILED KANGAROO RATS OF THE *DIPODOMYS PHILLIPSII* GROUP

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ABSTRACT.—Both nongeographic and geographic variation was assessed in southern banner-tailed kangaroo rats of the nominal species *Dipodomys phillipsii* and *D. ornatus*. Univariate and multivariate analyses were employed in consideration of geographic variation. *D. ornatus* is arranged as a subspecies of *D. phillipsii*, in which four races (*phillipsii*, *ornatus*, *perotensis*, and *oaxacae*) are recognized. Some observations on natural history also are included.

The southern banner-tailed kangaroo rat, *Dipodomys phillipsii*, originally was described by Gray (1841:522), based on a specimen from "near Real del Monte," Hidalgo, and is the type species of the genus *Dipodomys*. The holotype remained the only known specimen of *phillipsii* until Merriam (1893) reported on material and field observations obtained by E. W. Nelson in the vicinity of Mexico City, and in the states of Tlaxcala, Puebla, and Veracruz. In the following year, Merriam (1894:110–111) named *Dipodomys ornatus* and *Dipodomys perotensis*, based on specimens from Berriozábal, Zacatecas, and Perote, Veracruz, respectively, as species that resembled *D. phillipsii*. Davis (1944:391) reduced *perotensis* to subspecific status under *phillipsii*, but *ornatus* has stood until now in the literature as a distinct species. Finally, Hooper (1947) described *Dipodomys phillipsii oaxacae* from Teotitlán, Oaxaca, distinguishing it from other known races on the basis of small size and pale coloration. For the currently recognized groups of kangaroo rats, see Lidicker (1960*a*:134).

Although southern banner-tailed kangaroo rats have been mentioned in various publications dealing with the mammalian faunas of northern and central México, no previous attempt has been made to assess systematically the relationships within this group. Our study is based on 251 specimens, many of them obtained in the last two decades, and includes analysis of both nongeographic and geographic variation in these rats. We have also summarized the available information on natural history.

METHODS AND ACKNOWLEDGMENTS

All measurements recorded beyond are in millimeters; those recorded for crania were taken by means of dial calipers, whereas external dimensions are those recorded on specimen labels by field collectors. The measurement depth of cranium was taken using a glass microscope slide as described by Hooper (1952:10). Bacula were measured under a binocular microscope fitted with an ocular micrometer and were drawn with the aid of an ocular grid. Variation in color was assessed using a Photovolt Photoelectric Reflection Meter, Model 610, which gives reflectance readings as a percentage of pure white (see Lawlor, 1965, and Dunnigan, 1967). Readings were taken with red, green, and blue filters in the middorsal region on skins with unworn pelage.

All statistical analyses were performed on the GE 635 computer at The University of Kansas. Univariate analyses were carried out using a program (UNIVAR) written by Power (1970). This program yields standard statistics (mean, range, standard deviation, standard error of the mean, variance, and coefficient of variation) and, when two or more groups are being compared, employs a single-classification analysis of variance (F-test, significance level .05) to test for significant differences between or among the means of the groups (Sokal and Rohlf, 1969). When means were found to be significantly different, the Sums of Squares Simultaneous Test Procedure (SS-STP) was used to determine the maximally nonsignificant subsets.

Multivariate analyses were performed using the NT-SYS programs developed at The University of Kansas by F. J. Rohlf, R. Bartcher, and J. Kishpaugh. Matrices of Pearson's product-moment correlation were computed, and phenetic distance coefficients were derived from standardized character values. Cluster analyses were conducted using UPGMA (unweighted pair-group method using arithmetic averages) on the correlation and distance matrices. A matrix of correlation among characters then was computed and the first three principal components extracted. A three-dimensional stereogram was not prepared from these data because two-dimensional plots were sufficient to depict relationships among the samples studied of the southern banner-tailed kangaroo rat. Discussions of the theory underlying these tests are given by Schnell (1970:42–44) and Atchley (1970:206–212); Choate (1970) and Rising (1970) have used these techniques in studies similar to ours.

In order to obtain samples of a sufficient number of specimens for statistical analysis, it was necessary in many cases to group specimens from several geographic localities. In so doing, we attempted to keep the area concerned as small as possible, and we did not include specimens from more than one major physiographic region nor cross any previously recognized taxonomic boundaries. Specimens labeled with reference to the following geographic places comprised the samples used in our analysis (see Fig. 2): sample 1—*Durango* (Durango, Laguna de Santiaguillo, Morcillo, Vicente Guerrero); sample 2—*Durango* (La Pila); sample 3—*Zacatecas* (Hda. San Juan Capistrano, Valparaíso); sample 4—*Jalisco* (La Mesa María de León); sample 5—*Zacatecas* (Berriozábal, Fresnillo, Plateado, Trancoso, Villanueva, Zacatecas); sample 6—*Aguascalientes* (Aguascalientes, Rincón de Romos), and *Jalisco* (Encarnación de Díaz, Villa Hidalgo); sample 7—*Jalisco* (Guadalupe de Victoria, Lagos, Matanzas) and *San Luis Potosí* (Arenal, Bledos); sample 8—*Guanajuato* (León); sample 9—*Querétaro* (Tequisquiapam); sample 10—*Distrito Federal* (Ajusco, Mexico City, Tlalpam) and *México* (Amecameca, Texcoco); sample 11—*Tlaxcala* (Huamantla); sample 12—*Puebla* (Lago Salido) and *Veracruz* (Guadalupe Victoria, Limón, Perote); sample 13—*Puebla* (Chalchicomula, Puebla); sample 14—*Oaxaca* (Teotitlán); sample 15—*Puebla* (Tehuitzingo).

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Nongeographic Variation

Variation with age.—All specimens examined were assigned to one of three age categories and these were studied in order to determine which should be used in taxonomic comparisons. Age categories, modified after Hall and Dale (1939:49–50) and Lidicker (1960*a*:128), were as follows:

juvenile—deciduous premolars present;
young—permanent premolars present, but slightly worn, and re-entrant enamel angle still present on lingual edge of upper premolars;
adult—re-entrant angle no longer present on upper premolars, occlusal surface of premolars oval in outline.

No "old adults" were found among the available specimens. Juveniles and young were present only in limited numbers and variation with age, therefore, was not tested statistically; it was obvious, however (Table 1), in comparing age classes in a sample from the vicinity of Perote, Veracruz, that individuals classed as juveniles or young were much smaller than adults. In only one measurement, depth of cranium, did young individuals have the same mean as adults, and juveniles averaged smaller than young in all measurements tested. We used only those individuals classed as adults in our analysis of geographic variation.

Juvenile pelage is grayer and darker dorsally than that of adults; furthermore, the individual hairs of juveniles seem to be finer than those of adults and juveniles are not so densely haired. We detected no pelage intermediate between those we have termed "juvenile" and "adult." There may be, however, an earlier pelage, as suggested by Eisenberg (1963:71), not represented in our specimens.

Individual variation.—The three external measurements used in this study had coefficients of variation in a series of adults from Chalchicomula, Puebla (see Table 2), that ranged from 1.8 (length of hind foot for females) to 4.1 (length of tail for males), whereas the six cranial measurements had a range of 1.4 (depth of cranium for males) to 4.1 (length of maxillary toothrow for males and interorbital breadth for females). These values are well within the range of those for rodents of similar size as cited by Long (1968:210–213, 1969:300–301). Males had higher coefficients of variation in four measurements (total length, length of tail, length of hind foot, and greatest length of skull), and females were more variable in the other five.

TABLE 1.—*Variation with age in a sample of* Dipodomys phillipsii *from vicinities of Perote and Limón, Veracruz.*

Measurement	Juvenile N	Juvenile Mean (Range)	Young N	Young Mean (Range)	Adult N	Adult Mean (Range)
Total length	4	234.3 (215.0–244.0)	4	266.2 (261.0–270.0)	15	270.7 (254.0–304.0)
Length of tail	4	144.0 (137.0–151.0)	4	159.0 (154.0–166.0)	15	164.8 (149.0–190.0)
Length of hind foot	4	38.0 (34.0–40.0)	4	39.8 (39.0–40.0)	16	40.5 (38.0–44.0)
Greatest length of skull	2	33.4 (32.0–34.8)	4	36.4 (35.9–36.9)	13	37.4 (35.3–38.7)
Length of max. toothrow		————	4	4.8 (4.5–5.1)	17	4.9 (4.2–6.0)
Depth of cranium	3	13.2 (12.8–13.4)	4	13.4 (13.0–13.8)	12	13.4 (12.9–13.7)
Mastoid breadth	4	21.6 (21.0–22.5)	4	22.8 (22.2–23.1)	16	23.4 (22.7–24.5)
Maxillary breadth	2	18.3 (17.7–18.8)	4	19.8 (19.5–20.1)	15	20.9 (20.0–22.1)
Interorbital constriction	3	10.5 (9.5–12.0)	4	12.6 (12.3–12.7)	12	13.0 (12.3–14.1)

Color is geographically variable in southern banner-tailed kangaroo rats, but varies to a greater degree among rats from a single locality than do external or cranial measurements. For example, among 14 geographic samples analyzed by us, reflectance of red ranged from 5.5 to 13.1 in coefficient of variation.

Secondary sexual variation.—Analysis of variance was used to test each of nine measurements in a sample from Puebla (Table 2) to determine if the means were significantly different between sexes. Males were found to be significantly longer than females at the .01 level for total length and at the .05 level for length of tail. No significant differences were found between the sexes in the remaining seven measurements, although males averaged slightly larger in all except depth of cranium. We combined values for the two sexes in geographic analysis, but attempted to keep males and females in similar proportions in the samples analyzed.

Seasonal variation.—Molt from one adult pelage to another appears to occur semiannually. The first molt probably begins in late March or early April (9 April earliest date recorded), with all individuals completing the molt by late July (23 July latest date recorded). The second molt begins in mid-September (14 September earliest date recorded) and is completed by mid- or late December (14 December latest date recorded). The pattern of molt is similar to that recorded for *Perognathus parvus* by Speth (1969). Molt begins dorsally just behind the ears and progresses anteriorly and posteriorly as well as ventrally. We detected no seasonal differences in color of pelage in the material at hand.

TABLE 2.—*Secondary sexual variation in adult* Dipodomys phillipsii *from Chalchicomula, Puebla.*

Sex	*N*	Mean ± 2 SE (Range)	CV	F_s/F
		Total length		
Male	17	278.4 ± 4.62(252.0–291.0)	3.4	9.84**
Female	13	268.2 ± 4.29(258.0–283.0)	2.9	4.20
		Length of tail		
Male	17	172.2 ± 3.46(158.0–182.0)	4.1	4.48*
Female	13	167.0 ± 3.29(159.0–178.0)	3.6	4.20
		Length of hind foot		
Male	19	41.3 ± 0.43(40.0–43.0)	2.3	3.33ns
Female	13	40.8 ± 0.42(40.0–42.0)	1.8	4.17
		Greatest length of skull		
Male	18	37.5 ± 0.44(35.7–38.8)	2.5	2.23ns
Female	13	37.0 ± 0.44(35.7–38.3)	2.1	4.18
		Length of maxillary toothrow		
Male	19	4.9 ± 0.09(4.5–5.3)	4.1	3.70ns
Female	13	4.8 ± 0.11(4.4–5.2)	4.3	4.17
		Depth of cranium		
Male	18	13.3 ± 0.09(12.7–13.5)	1.4	1.49ns
Female	13	13.4 ± 0.16(12.9–14.0)	2.2	4.18
		Mastoid breadth		
Male	19	23.1 ± 0.21(22.3–24.0)	2.0	0.12ns
Female	13	23.0 ± 0.34(22.0–23.9)	2.6	4.17
		Maxillary breadth		
Male	17	20.9 ± 0.23(20.2–21.9)	2.3	0.65ns
Female	13	20.7 ± 0.46(19.5–22.2)	4.0	4.20
		Interorbital constriction		
Male	15	12.7 ± 0.15(12.3–13.3)	2.2	0.95ns
Female	10	12.5 ± 0.32(11.8–13.4)	4.1	4.28

GEOGRAPHIC VARIATION

Specimens of the nominal species *Dipodomys ornatus* and *D. phillipsii* were grouped into 14 samples for univariate analysis of geographic variation; a fifteenth sample consisting of a single individual was added for the multivariate analysis (see section on methods and Fig. 2). Samples 1 to 8 are from the geographic range of *Dipodomys ornatus* (as understood at the outset of this study), whereas samples 10 to 15 are from within the known range of *D. phillipsii.* Sample 9 is from an area intermediate between the previously known ranges of the two taxa. Table 3 gives standard statistics for external and cranial measurements and for color reflectance of rats from the 15 samples.

Univariate Analysis

External measurements.—Total length and length of the tail exhibit little significant geographic variation. The SS-STP yielded only two nonsignificant subsets for both measurements. For total length the first subset is composed of all localities except number 14 and the second subset contained samples 1, 2, 8, 12, and 14. Examination of means for total length revealed that only two samples, 2 (264.0) and 14 (244.3), yielded values that did not fall between 270 and 280. The first subset for length of tail again included all samples excepting 14, whereas the second subset included all save 9; the mean for specimens comprising sample 14 (157.0) is much smaller than the others, which have values ranging from 162.3 (sample 2) to 176.7 (sample 9). Length of the hind foot exhibited slightly more geographic variation than did other external measurements, being divided into three nonsignificant subsets (Table 4): the first contained all samples excepting 5 (central Zacatecas), 2 (La Pila, Durango), and 14 (Teotitlán, Oaxaca); sample 3 (western Zacatecas) with the largest mean (42.0) and sample 14 with the smallest (36.3) were the only samples not included in the second subset, whereas the last subset consisted of samples 2, 5, and 14. Inspection of means for length of hind foot revealed no noteworthy breaks in the continuum of variation, except for that between sample 14 and the next nearest mean value, 40.0 (sample 2).

Cranial measurements.—Means for greatest length of skull were arranged in five broadly overlapping nonsignificant subsets (Table 4). Specimens from Tlaxcala (sample 11), Veracruz (12), central Puebla (13), and Querétaro (9) have, on the average, the longest skulls (mean values for greatest length, 37.2 to 37.5). Samples from Zacatecas, Jalisco, Aguascalientes, San Luis Potosí, and Guanajuato (3 to 8) as well as the sample (10) from Estado de México and the Distrito Federal have means ranging from 36.2 to 36.5, and the two samples from Durango (1 and 2) are only slightly smaller (35.5 and 35.8). Specimens from Teotitlán, Oaxaca (sample 14), averaged smallest, with a mean length of skull of 34.1.

Length of the maxillary toothrow exhibited little geographic variation, having only two broadly overlapping subsets. The first contained all samples except 13 (central Puebla), 7 (northeastern Jalisco and western San Luis Potosí), and 14 (Teotitlán, Oaxaca), whereas the second contained all samples except the largest individuals, represented by sample 9 (Querétaro). All samples have a mean length of maxillary toothrow in the range of 4.8 to 5.0 with the exception of sample 9 (mean 5.3) and sample 14 (4.4).

Means for depth of cranium were arranged into three nonsignificant subsets. The first contained all samples with the exception of 1, 2, and 14, which have the shallowest crania. Omitted from the second subset are samples 6 (with the deepest cranium) and sample 14 (with the shallowest). The third subset is made up of samples 1, 2, 4, 9, 10, and 14. Visually, the means for this measurement form an unbroken series from 13.0 (value of samples 1 and 2) to 13.6 (value of sample 6), except for sample 14, in which the depth of cranium averaged only 12.5.

Means for mastoid breadth fell into five broadly overlapping nonsignificant subsets. Little can be discerned from examination of these subsets, but the size-order of means is of interest. Samples from Veracruz, Puebla, and Tlaxcala (11 to 13), along with those from Querétaro and Guanajuato (8 and 9), averaged largest in mastoid breadth with values of 22.9 to 23.4. Next in order of decreasing size are samples from Jalisco, Aguascalientes, Zacatecas, and San Luis Potosí (3 to 7) with means of 22.6 to 22.8. The sample from México and Distrito Federal (10) averaged 22.5, followed by two samples from Durango (1 and 2) with values of 22.4 and 22.2. Specimens from northern Oaxaca (14) averaged narrowest in mastoid breadth (21.3) among the samples studied.

Means for maxillary breadth formed five broadly overlapping subsets and are of considerable interest when compared with means of mastoid breadth. The average maxillary breadth in samples 8 and 9 (22.5 and 22.0) is large, as were the means for mastoid breadth in these samples. Next in size in maxillary breadth are the samples from Jalisco, Aguascalientes, and San Luis Potosí (means 21.4 to 21.7), and these also grouped together in mastoid breadth. Near the middle of the range of variation for the species is the sample from the vicinity of Mexico City (10) and the two Durangan samples (1 and 2), with values of 21.0 to 21.3; these three groups had the smallest means, with the exception of sample 14, for mastoid breadth. The three samples from Veracruz, Puebla, and Tlaxcala (11 to 13) averaged relatively narrow (mean values 20.8 and 20.9), but it is noteworthy that specimens from these samples averaged among the broadest in mastoid breadth. Specimens from Oaxaca (14) averaged narrowest in maxillary breadth (18.8) as they did also in mastoid breadth.

Means for interorbital constriction fell into six broadly overlapping subsets (Table 4). For this measurement, sample 10 had the largest mean although for maxillary breadth it was near the middle of the range of variation and for mastoid breadth it was among the smallest. Samples 8 and 9 again are among the broadest, as they were for the two previous breadth measurements. Specimens from Jalisco, Aguascalientes, Zacatecas, San Luis Potosí, and Durango (1 to 7) fell in the middle part of the range of variation, as they did for other breadth measurements. Specimens from Veracruz, Puebla, and Tlaxcala (11 to 13) have, on the average, narrow interorbital regions compared with those of other samples, and specimens from northern Oaxaca (14) averaged narrowest in interorbital constriction.

Color reflectance.—The six nonsignificant subsets into which means for red reflectance fell are shown in Table 4. No overall trend in geographic variation is apparent. Specimens from Jalisco and San Luis Potosí (sample 7) and those from northern Oaxaca (14) had the highest reflectance readings. Most of the northern populations had high readings with the exception of samples

TABLE 3.—*Geographic variation in external dimensions, cranial dimensions, and color among 15 samples (see text and Fig. 2) of southern banner-tailed kangaroo rats.*

Statistics	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12	Sample 13	Sample 14	Sample 15
							Total length								
N	12	7	7	8	13	9	19	4	11	16	3	12	30	3	1
Mean	271.5	264.0	275.4	275.8	274.1	277.8	277.6	273.0	279.0	275.3	279.7	270.7	274.0	244.3	252.0
Minimum	255.0	253.0	252.0	260.0	259.0	264.0	257.0	263.0	264.0	259.0	268.0	254.0	252.0	230.0	
Maximum	288.0	282.0	289.0	302.0	295.0	302.0	297.0	282.0	290.0	285.0	295.0	304.0	291.0	255.0	
2 SE	5.82	8.32	9.08	8.92	5.98	8.65	4.75	7.87	4.26	4.71	16.01	6.66	3.67	14.89	
							Length of tail								
N	12	7	7	8	13	9	19	4	11	16	3	15	30	3	1
Mean	169.3	164.3	173.3	168.5	172.7	171.6	172.2	169.5	176.7	172.9	175.0	164.8	169.9	157.0	155.0
Minimum	151.0	155.0	164.0	160.0	162.0	162.0	156.0	167.0	167.0	160.0	165.0	149.0	158.0	150.0	
Maximum	188.0	175.0	183.0	192.0	188.0	190.0	190.0	174.0	185.0	182.0	186.0	190.0	182.0	161.0	
2 SE	6.12	5.32	5.84	8.25	4.17	6.76	4.30	3.32	2.66	3.66	12.17	5.51	2.57	7.02	
							Length of hind foot								
N	14	7	10	9	16	9	18	6	11	17	3	16	32	3	1
Mean	40.3	40.0	42.0	41.1	40.2	40.4	40.5	41.2	41.8	41.2	41.0	40.5	41.1	36.3	34.0
Minimum	38.0	38.0	39.0	39.5	38.0	39.0	38.0	40.0	41.0	39.0	40.0	38.0	40.0	36.0	
Maximum	42.0	42.0	45.0	44.0	42.5	44.5	42.5	42.0	43.0	43.5	42.0	44.0	43.0	37.0	
2 SE	0.57	1.06	1.39	0.84	0.60	1.24	0.54	0.61	0.47	0.57	1.15	0.91	0.32	0.67	
							Greatest length of skull								
N	11	8	10	9	14	8	18	6	9	16	2	13	31	3	1
Mean	35.5	35.8	36.5	36.2	36.5	36.3	36.4	36.4	37.2	36.5	37.5	37.4	37.3	34.1	34.4
Minimum	34.4	34.4	34.3	35.0	35.4	34.7	34.7	35.5	36.2	35.0	37.0	35.3	35.7	34.0	
Maximum	36.9	36.8	37.6	37.2	37.7	38.1	37.7	37.2	38.0	37.5	38.0	38.7	38.8	34.3	
2 SE	0.58	0.60	0.76	0.53	0.35	0.78	0.35	0.56	0.41	0.36	1.00	0.51	0.32	0.18	
							Length of maxillary toothrow								
N	14	8	9	9	17	9	19	6	11	16	3	17	32	3	1
Mean	5.0	4.9	5.0	4.9	4.9	5.0	4.8	4.9	5.3	5.0	5.0	4.9	4.8	4.4	4.4
Minimum	4.2	4.5	4.6	4.4	4.6	4.7	4.3	4.5	5.0	4.7	4.9	4.2	4.4	4.4	
Maximum	5.4	5.3	5.3	5.1	5.4	5.3	5.2	5.1	5.5	5.3	5.0	6.0	5.3	4.5	
2 SE	0.17	0.24	0.18	0.16	0.11	0.15	0.09	0.20	0.12	0.09	0.07	0.21	0.07	0.07	
							Depth of cranium								
N	12	7	10	8	14	8	13	6	7	14	3	12	31	3	1
Mean	13.0	13.0	13.3	13.2	13.3	13.6	13.2	13.3	13.2	13.2	13.2	13.4	13.3	12.5	12.6
Minimum	12.6	12.5	12.8	13.0	13.0	12.8	12.9	13.1	12.8	12.8	13.1	12.9	12.7	12.4	
Maximum	13.6	13.3	13.6	13.6	13.6	14.4	13.6	13.5	13.6	13.6	13.3	13.7	14.0	12.5	
2 SE	0.15	0.20	0.20	0.14	0.13	0.36	0.13	0.14	0.20	0.13	0.13	0.13	0.09	0.07	

TABLE 3. *Continued*

Statistics	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12	Sample 13	Sample 14	Sample 15
							Mastoid breadth								
N	13	8	10	9	17	8	19	6	11	15	3	16	32	3	1
Mean	22.4	22.2	22.6	22.7	22.8	22.8	22.8	23.3	23.0	22.5	22.9	23.4	23.0	21.3	21.4
Minimum	21.7	21.4	20.8	22.0	21.9	21.5	21.7	22.9	22.3	22.0	22.2	22.7	22.0	21.1	
Maximum	23.9	22.5	24.0	23.6	23.4	23.8	23.3	23.8	23.5	23.0	23.3	24.5	24.0	21.6	
2 SE	0.36	0.28	0.68	0.34	0.20	0.55	0.22	0.30	0.22	0.16	0.73	0.28	0.18	0.31	
							Maxillary breadth								
N	15	7	9	9	15	9	16	5	11	11	3	15	30	3	1
Mean	21.1	21.2	21.4	21.4	21.7	21.6	21.6	22.5	22.0	21.3	20.8	20.9	20.8	18.8	18.9
Minimum	19.6	20.2	19.7	20.6	19.4	20.8	20.9	21.8	21.3	20.4	20.0	20.0	19.5	18.4	
Maximum	21.9	21.9	22.3	21.9	22.9	23.1	22.1	22.9	22.6	22.1	21.2	22.1	22.2	19.5	
2 SE	0.32	0.43	0.62	0.29	0.48	0.47	0.20	0.44	0.24	0.39	0.77	0.31	0.24	0.70	
							Interorbital constriction								
N	15	7	10	9	17	9	19	6	10	13	2	12	25	3	1
Mean	13.2	13.5	13.1	13.2	13.5	13.4	13.2	14.0	14.0	14.1	13.1	13.0	12.6	12.1	11.2
Minimum	12.6	12.9	12.7	12.5	12.5	13.1	12.5	13.4	13.3	13.2	13.0	12.3	11.8	11.7	
Maximum	13.5	14.0	13.7	13.9	14.3	13.8	14.0	14.2	14.6	14.5	13.1	14.1	13.4	12.5	
2 SE	0.13	0.28	0.21	0.29	0.25	0.15	0.19	0.26	0.32	0.20	0.10	0.31	0.15	0.47	
							Reflected red								
N	7	6	4	8	7	9	8	6	8	11	2	13	12	2	1
Mean	15.6	15.5	14.6	14.4	16.9	17.2	18.2	15.2	16.3	12.1	17.3	15.4	14.1	18.0	15.0
Minimum	14.5	14.0	13.0	11.5	15.0	15.0	17.0	14.0	15.0	10.5	16.5	12.5	13.0	17.0	
Maximum	17.0	17.0	17.0	17.5	21.0	19.5	20.0	17.0	18.5	13.0	18.0	17.5	16.0	19.0	
2 SE	0.75	0.97	1.70	1.33	1.50	0.91	0.80	0.92	0.78	0.40	1.50	0.88	0.69	2.00	
							Reflected green								
N	7	6	4	8	7	9	8	6	8	11	2	13	12	2	1
Mean	9.4	8.3	8.0	8.1	9.2	9.3	9.3	8.3	8.1	6.6	9.5	8.7	8.1	10.3	8.0
Minimum	8.0	7.0	7.0	6.5	7.5	8.5	8.0	7.0	7.0	6.0	8.5	7.0	7.0	9.5	
Maximum	12.0	9.5	9.0	10.5	12.0	11.0	10.5	10.5	9.0	7.0	10.5	10.5	10.5	11.0	
2 SE	0.97	0.72	0.82	1.04	1.21	0.60	0.60	1.17	0.45	0.24	2.00	0.62	0.66	1.50	
							Reflected blue								
N	7	6	4	8	7	9	8	6	8	11	2	13	12	2	1
Mean	7.5	7.3	6.4	6.3	7.6	7.9	7.6	6.9	6.8	5.9	8.0	7.5	6.9	8.8	7.5
Minimum	6.5	6.0	6.0	5.0	6.5	7.5	6.5	6.5	5.5	4.5	7.5	6.5	6.0	8.5	
Maximum	8.5	9.5	7.0	7.5	9.5	9.0	8.5	7.5	7.5	6.5	8.5	8.5	10.5	9.0	
2 SE	0.49	0.99	0.48	0.63	0.89	0.39	0.48	0.40	0.50	0.38	1.00	0.44	0.72	0.50	

TABLE 4.—*Results of four typical SS-STP analyses of geographic variation in southern banner-tailed kangaroo rats. Geographic origin of samples is shown in Fig. 2. Horizontal lines connect means of maximally nonsignificant subsets at the .05 level.*

Length of hind foot

Sample	3	9	10	8	13	4	11	12	7	6	1	5	2	14
Mean	42.0	41.8	41.2	41.2	41.1	41.1	41.0	40.5	40.5	40.4	40.3	40.2	40.0	36.3

Greatest length of skull

Sample	11	12	13	9	5	10	3	7	8	6	4	2	1	14
Mean	37.5	37.4	37.3	37.2	36.5	36.5	36.5	36.4	36.4	36.3	36.2	35.8	35.5	34.1

Interorbital constriction

Sample	10	9	8	2	5	6	4	7	1	3	11	12	13	14
Mean	14.1	14.0	14.0	13.5	13.5	13.4	13.2	13.2	13.2	13.1	13.1	13.0	12.6	12.1

Color (red reflectance)

Sample	7	14	11	6	5	9	1	2	12	8	3	4	13	10
Mean	18.2	18.0	17.3	17.2	16.9	16.3	15.6	15.5	15.4	15.2	14.6	14.4	14.1	12.1

3 and 4, which are from relatively high elevations as compared with other samples from Jalisco and Zacatecas. Specimens from Tlaxcala (11) also had high values of reflected red. The two samples (12 and 13) that often grouped with sample 11 in external and cranial measurements fell among those with the low mean values for red reflectance. The sample from the vicinity of Mexico City (sample 10) had the lowest mean reading for red reflectance. The average value for this sample is a full 2 per cent less in reflectance than is the next lowest mean value (sample 13).

Samples fell into three broadly overlapping, nonsignificant subsets for reflectance of green and four for reflectance of blue. They revealed approximately the same relationship as for reflected red. Sample 10 had a much lower mean than the other samples for green and blue, as it did for red.

Multivariate Analysis

Means for each sample for the three external and six cranial measurements and three color reflectance values were used in a NTSYS-multivariate analysis. Phenograms diagramming the phenetic relationships of southern banner-tailed kangaroo rats were computed by cluster analysis from both distance and cor-

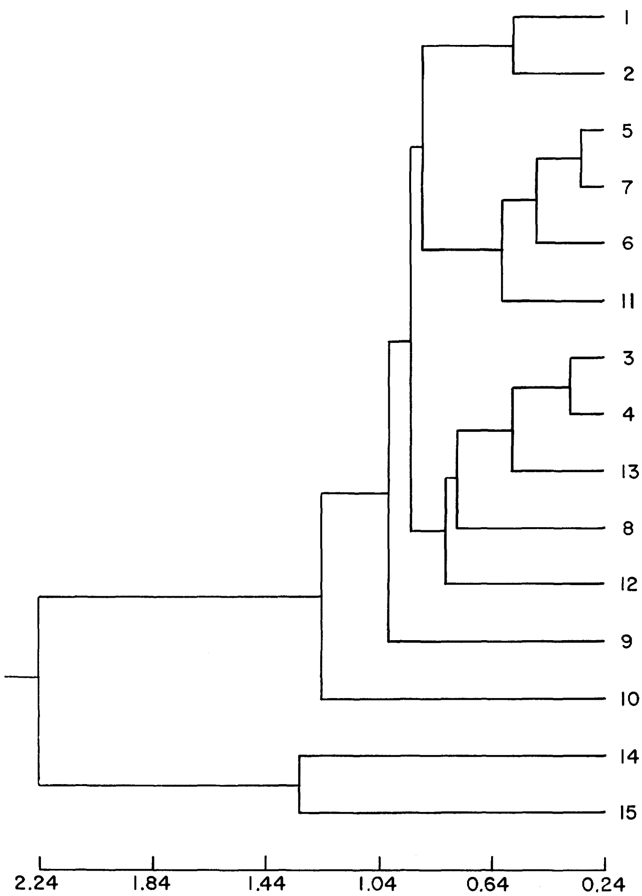

FIG. 1.—Distance phenogram resulting from cluster analysis of 15 geographic samples (see Fig. 2) of southern banner-tailed kangaroo rats.

relation matrices; the phenogram based upon the distance matrix is presented in Fig. 1. The samples in this phenogram are divided into two major clusters, one consisting of samples 14 and 15 and the second containing all others. Samples 14 and 15 are distantly separated in the first cluster. In the second cluster there are at least four major subclusters. Two of these consist of single samples 9 and 10, but the other two contain five (3, 4, 8, 12, and 13) and six samples (1, 2, 5, 6, 7, and 11). The coefficient of cophenetic correlation for the distance phenogram was 0.931.

Fig. 2 indicates the approximate areas from which the samples were drawn and the distance coefficient between the connected samples. In most cases, for ease of diagrammatic presentation, we have connected only adjacent samples. The largest distance coefficients were found between samples 13 and 14 (2.568) and between 13 and 15 (1.815). Distance coefficients of more than

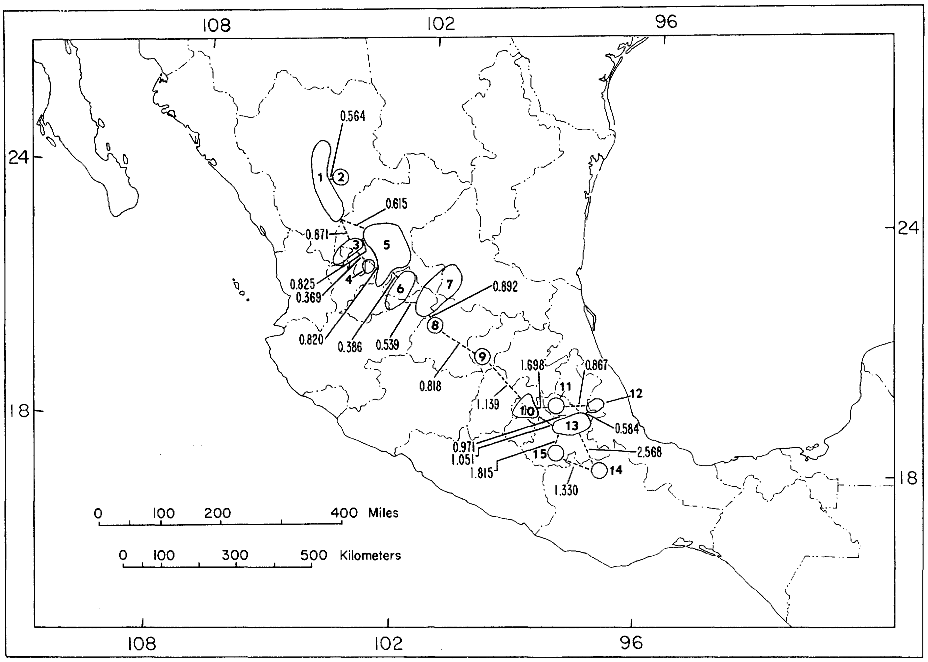

FIG. 2.—Map showing geographic location of 15 samples of southern banner-tailed kangaroo rats used for numerical analysis in this study, and distance coefficients between adjacent samples.

1.00 were generated between samples 9 and 10, 10 and 11, 10 and 13, and 14 and 15, and a coefficient of 0.971 was found between samples 11 and 13. Distance coefficients of 0.8 to 0.9 were common, being found between six sets of localities.

The first three principal components were computed from the matrix of correlation among the 12 characters. The first principal component expresses 64.16 per cent of the phenetic variation, the second 19.09, and the third 6.30. Two-dimensional plots of the three principal components are shown in Fig. 3. From the results of the factor analysis (Table 5), it appears that both external and cranial size had a strong influence on the first component. With respect to positioning of samples along component I, the sample containing specimens that were smallest overall (14) is located on the far right; from that point, samples are arranged in ascending order relative to size, with the sample consisting of the largest individuals (sample 9) on the far left of the plot. Major factors in the second component were the color reflectance ratings, although depth of cranium and mastoid breadth had some influence. The positioning of samples along component II reveals that sample 10, which contained the darkest individuals, is near the top of the plot, and that samples 3 and 4, which also had low reflectance readings, occupy a somewhat lower

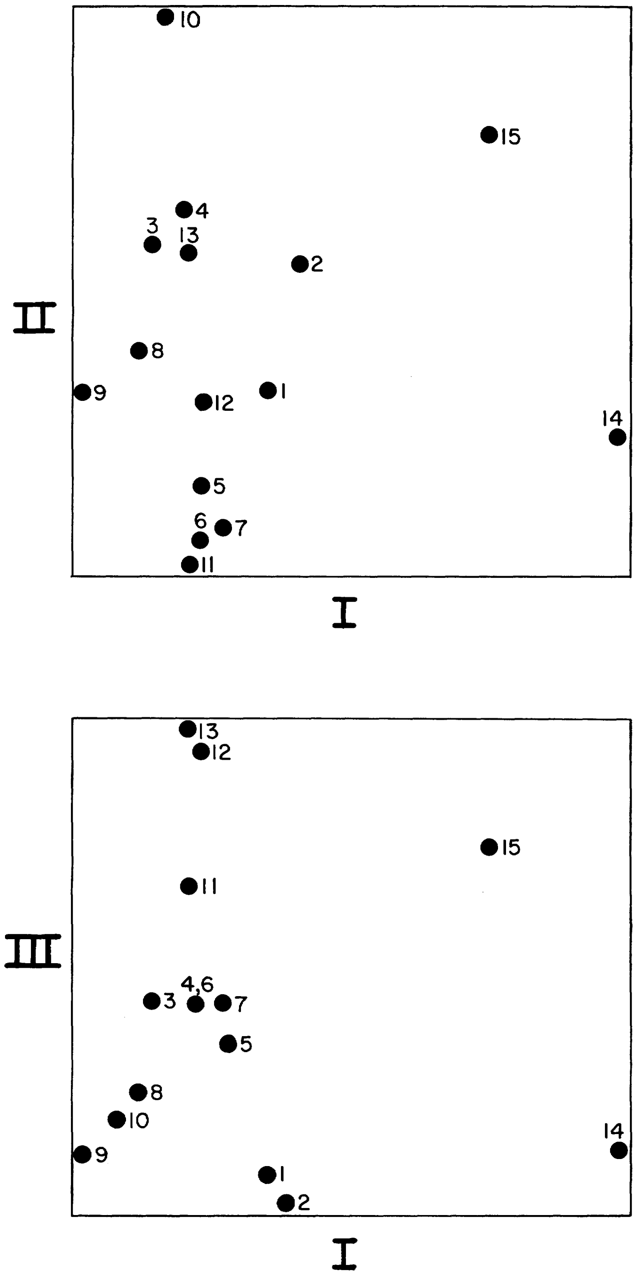

FIG. 3.—Two-dimensional projections of the first three principal components, illustrating the phenetic position of 15 samples of southern banner-tailed kangaroo rats. Top, component I plotted against component II; bottom, component I plotted against component III.

TABLE 5.—*Factor matrix from correlation among the 12 characters studied.*

Measurement	Factor Component I	Factor Component II	Factor Component III
Total length	–0.922	–0.135	0.150
Length of tail	–0.867	–0.159	–0.043
Length of hind foot	–0.947	–0.072	–0.077
Greatest length of skull	–0.848	–0.163	0.423
Length of maxillary toothrow	–0.891	–0.109	–0.224
Depth of cranium	–0.867	–0.246	0.195
Mastoid breadth	–0.854	–0.230	0.330
Maxillary breadth	–0.891	–0.137	–0.277
Interorbital constriction	–0.805	–0.093	–0.505
Reflected red	0.332	–0.904	–0.106
Reflected green	0.467	–0.852	–0.050
Reflected blue	0.659	–0.720	0.065

position on the component. Near the bottom of component II are samples that averaged high in reflectance readings. Factor analysis (Table 5) indicates that loading in the third component had high positive values for greatest length of skull and mastoid breadth and high negative values for maxillary breadth and interorbital constriction. The three samples (11, 12, and 13) that separate from the others in the third principal component are those that were shown in the univariate analysis to have among the largest means for mastoid breadth and among the smallest for maxillary breadth and interorbital constriction. The single specimen in sample 15 also appears to fall in the third component with samples 11, 12, and 13, but it is widely separated from these samples in component I, which indicates that in overall size this specimen is much smaller than those in samples 11, 12, and 13.

Bacular Morphology

The bacula of *Dipodomys ornatus* (Lidicker, 1960*b*:496) and *Dipodomys phillipsii* (Burt, 1960:45) have been figured previously, but no comparison between them has been made. Burt (*op. cit.*) stated that the morphology of the single baculum from a Oaxacan specimen that he examined differed from all others in the genus in that the tip is upturned at a sharp angle from the shaft. This is not the case, however, in bacula of two specimens that we examined from México and Veracruz. These do have an upturned tip (Fig. 4), but the angle between the tip and shaft appears similar to that figured by Burt (1960:pl. 12) for other *Dipodomys*. The bacula of four specimens from within the previously understood range of *ornatus* (two from Jalisco, one each from Zacatecas and Guanajuato) agree morphologically with those figured by Lidicker (1960*b*:496) from Aguascalientes.

Little difference is evident in construction and morphology of the bacula of *ornatus* and *phillipsii*. That of *ornatus* is somewhat the larger, but it should be noted that the bacula of *phillipsii* we examined were from young adults,

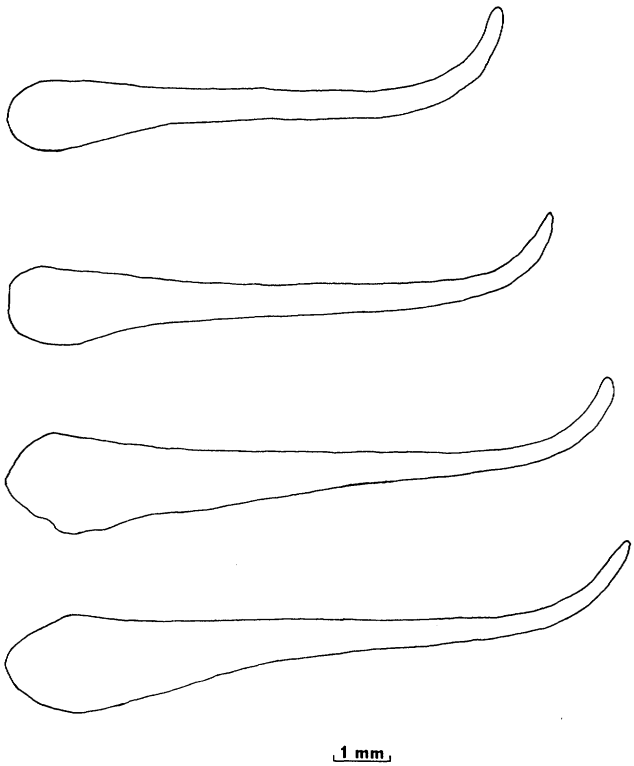

FIG. 4.—Bacula of four southern banner-tailed kangaroo rats. Specimens represented (from top to bottom) are as follows: KU 19384, 2 km E Perote, Veracruz; KU 48987, 5 mi. S, 1 mi. W Texcoco, México; KU 48975, 8 mi. SE Zacatecas, Zacatecas; KU 48986, 4 mi. N, 5 mi. W León, Guanajuato.

because no other material was available. Bacular measurements are as follows (specimens from, respectively, México, Veracruz, Burt's rat from Oaxaca, Zacatecas, two from Jalisco, Guanajuato, mean and range of five bacula from Aguascalientes examined by Lidicker): length of baculum, 10.0, 9.1, 10.5, 11.3, 11.3, 11.1, 11.5, 12.2 (11.7–12.7); height of base, 1.3, 1.4, 1.3, 1.6, 2.0, 2.0, 1.4, 1.8 (1.4–2.2); width of base, 1.0, 0.9, 1.2, 1.6, 1.5, 1.6, 1.8, 1.6 (1.5–1.9).

Taxonomic Conclusions

We interpret the univariate and multivariate analyses as revealing that southern banner-tailed kangaroo rats represent one geographically variable species. The relatively minor cranial variations that Merriam (1894:110–111) used to characterize *D. ornatus* (such as a flatter cranium) are the result of individual and geographic variation within a population of this species. Therefore, in the following accounts all southern banner-tailed kangaroo rats are treated as a single species, *Dipodomys phillipsii* Gray.

Within *D. phillipsii*, we recognize four subspecies. In the north, from Querétaro to central Durango, is *Dipodomys phillipsii ornatus*, which is characterized by medium to large size, relatively pale coloration, and medium to broad cranium. The nominate race, *Dipodomys phillipsii phillipsii*, is confined to the Valle de México and immediate vicinity; it is characterized by medium size, dark coloration, and broad interorbital region. *Dipodomys phillipsii perotensis*, which occurs in Tlaxcala, Puebla, and Veracruz, can be distinguished by large size, coloration intermediate between that of *ornatus* and *phillipsii*, a broad mastoid region, and narrow interorbital and maxillary regions. The fourth subspecies, *Dipodomys phillipsii oaxacae*, known from northern Oaxaca and southern Puebla, is much smaller than the others and pale in color.

Synopsis of Subspecies

The four recognized subspecies of *D. phillipsii* are briefly described in the following accounts, and pertinent commentary is included on distribution and infrasubspecific variation. In the lists of specimens examined, localities in italic type are not plotted on the accompanying distribution map (Fig. 5) because crowded symbols would have resulted.

Dipodomys phillipsii phillipsii Gray

1841. *Dipodomys phillipii* [*sic*] Gray, Ann. Mag. Nat. Hist., ser. 1, 7:522 (see Coues, 1875:325, and Coues and Allen, 1877:540, for emendation of spelling). Type locality—"near Real del Monte," Hidalgo.

Distribution.—Confined to Valle de México and immediately adjacent areas in Hidalgo, México, and the Distrito Federal (see Fig. 5).

Remarks.—The nominal subspecies is characterized by dark dorsal coloration, broad maxillary and interorbital regions relative to mastoid breadth, and in being medium for the species in general size. For comparison of *D. p. phillipsii* with other subspecies of the species, see accounts of those taxa.

According to Merriam (1893:84–86), after collecting a large series of *D. phillipsii* near Mexico City, E. W. Nelson attempted to obtain specimens in the vicinity of the type locality, Real del Monte, Hidalgo, at the extreme northern edge of the Valley of Mexico. His search in the vicinities of Real del Monte, Pachuca, Tula, San Agustín, and Irolo, all in Hidalgo, proved unsuccessful, although en route from Pachuca to Irolo, Nelson noted an area south of Pachuca that he believed might be suitable habitat for these kangaroo rats. Based on his failure to obtain specimens near the type locality, Nelson concluded that the locality recorded by Gray was erroneous and that the holotype most likely had originated from somewhere near Tlalpam, which was one of the important cities in the Valley of Mexico in the mid-1800's, and a place where *D. phillipsii* was abundant. Later, however, a specimen was obtained on 22 August 1942 (Davis, 1944:391) at a place 85 km N Mexico City (approximately 9 km S Pachuca, Hidalgo) casting considerable doubt on Nelson's conclusion. We believe it best to consider that the holotype of *Dipodomys phillipsii* came from the vicinity of Real del Monte, Hidalgo, at least until more convincing evidence to the contrary is available.

The one specimen examined from south of Pachuca (TCWC 3028) is a male with deciduous premolars and still in juvenile pelage. The pelage of this specimen is darker than in juveniles of *ornatus*, but paler than in juveniles of typical *phillipsii*. The possibility exists that specimens from this area represent intergrades between *ornatus* and *phillipsii*, but

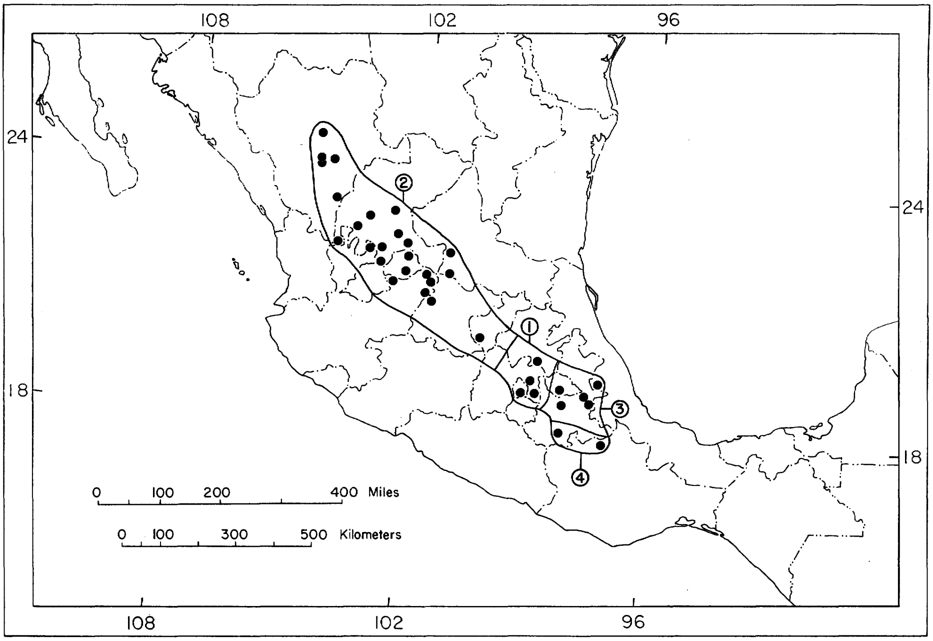

FIG. 5.—Distribution of subspecies of *Dipodomys phillipsii*: 1, *D. p. phillipsii*; 2, *D. p. ornatus*; 3, *D. p. perotensis*; 4, *D. p. oaxacae.*

adults are needed before any definitive statement can be made. One of us (Jones) did, however, examine the holotype (a badly preserved skin unaccompanied by skull) in the British Museum; its dorsal coloration is relatively dark, more or less typical of that found in specimens herein assigned to *phillipsii.*

Merriam (1893:86), quoting Nelson's field notes, stated that "they [*D. phillipsii*] were noted close to the peak of Huitzilac, near the Cruz del Marquez, at an altitude of 9000 feet." We have not seen specimens from this locality and it is not clear whether Nelson collected the rats there.

Specimens examined (38).—HIDALGO: near Real del Monte, 1 (BM—the holotype); 85 km N Mexico City, 8200 ft, 1 (TCWC). MEXICO: 5 mi. S, 1 mi. W Texcoco, 7350 ft, 1 (KU); *2 km S Huatongo, 2700 m,* 1 (UNAM); Amecameca, 3 (USNM). DISTRITO FEDERAL: *17 km ESE Mexico City,* 1 (TCWC) [labeled as in México, but reported as in the Distrito Federal by Villa-R., 1953:404, and Alvarez, 1961:409]; *Cerro de la Caldera, 2300 m,* 1 (ENCB); Tlalpam, 26 (USNM); *km 20 de la cerretera México-Tláhuac,* 1 (UNAM); *Ajusco,* 2 (USNM).

Dipodomys phillipsii ornatus Merriam

1894. *Dipodomys ornatus* Merriam, Proc. Biol. Soc. Washington, 9:110, 21 June. Type locality—Berriozábal, Zacatecas.

Distribution.—Recorded from the Mexican states of Durango, Zacatecas, Jalisco, Aguascalientes, San Luis Potosí, Guanajuato, and Querétaro. The northernmost record of occurrence is in the vicinity of Santa Cruz, Durango, and the southernmost is at Tequisquiapam, Querétaro (see Fig. 5).

Remarks.—This subspecies occupies the northern segment of the geographic range of the southern banner-tailed kangaroo rat. It is characterized by medium to large size and pale coloration. *D. p. ornatus* can be distinguished from *D. p. phillipsii* by its much paler color and relatively narrow interorbital region (57.9 to 60.9 per cent of mastoid breadth in nine samples of *ornatus* as compared with an average of 62.7 per cent in *phillipsii*). From *D. p. perotensis*, the subspecies *ornatus* differs in having a somewhat shorter skull on the average (greatest length in nine samples of *ornatus* ranged from 35.5 to 37.2 and in three of *perotensis* from 37.3 to 37.5), relatively broad maxillary and interorbital regions (maxillary breadth 94.2 to 96.6 per cent of mastoid breadth in *ornatus* and 89.3 to 90.8 in *perotensis*, interorbital breadth 57.9 to 60.9 per cent of mastoid breadth in *ornatus* and 54.8 to 57.2 in *perotensis*), and somewhat paler color. *D. p. ornatus* is easily distinguished from *D. p. oaxacae* by its much larger size.

A general increase in size in several cranial measurements was noted from north to south within the geographic range of *ornatus*. Samples from Durango generally had the smallest mean values, whereas those from Zacatecas, Aguascalientes, Jalisco, and San Luis Potosí were intermediate in size, and samples from Guanajuato and Querétaro had the largest mean values. Specimens from relatively high elevations (especially samples 3 and 4) average slightly darker in color than do those from lower areas.

Baker (1960:315–316) reported that individuals from the Guadiana lava fields (sample 2) were somewhat darker than typical specimens of *ornatus*. We find they are darker than rats from the vicinity of the type locality (sample 5), but that they are only slightly darker (revealed only in reflected green) than other specimens from Durango (sample 1), and that specimens from samples 3 and 4 are darker than those from the lava field in all three color readings taken (see Table 3).

Specimens from Tequisquiapam, Querétaro (9), show some tendencies toward *D. p. phillipsii*, but clearly are assignable to *ornatus*. They have the broadest interorbital region relative to mastoid breadth (60.9 per cent) of any sample of *ornatus*, and are somewhat darker than adjacent populations (as seen in reflectance readings of green and blue). Nevertheless, in all of these characters, the specimens from Querétaro resemble *ornatus* to a greater degree than *phillipsii*.

Alvarez (1961:409) cited from Dugés a record of *Dipodomys phillipsii* from San Diego de la Unión, Guanajuato. This record is of interest because it fills an otherwise rather broad gap in the known distribution of the species.

Specimens examined (141).—DURANGO: SE end Laguna de Santiaguillo, Santa Cruz, 4 (KU); 9 mi. N Durango, 6200 ft, 1 (KU); 6 mi. NW La Pila, 6150 ft, 10 (MSU); *4 mi. S Morcillo, 6450 ft,* 1 (MSU); Durango, 4 (USNM); 16 mi. S, 20 mi. W Vicente Guerrero, 6675 ft, 6 (MSU). ZACATECAS: 12 mi. N, 7 mi. E Fresnillo, 4 (UNM); Laguna Valderama, 40 mi. W Fresnillo, 7800 ft, 6 (CAS); Valparaíso, 16 (USNM); Zacatecas, 4 (USNM); *2 mi. S, 5 mi. E Zacatecas, 7700 ft,* 1 (MSU); *8 mi. SE Zacatecas, 7225 ft,* 4 (KU); *2 mi. ESE Trancoso, 7000 ft,* 1 (KU); Hda. San Juan Capistrano, 3 (USNM); Berriozábal, 2 (USNM); 2 mi. N Villanueva, 6500 ft, 1 (KU); Plateado, 5 (USNM). SAN LUIS POTOSI: 1 km N Arenal, 1 (LSU); *1 mi. W. Bledos,* 1 (LSU); Bledos, 1 (LSU). JALISCO: La Mesa María de León, 7400 ft, 14 (KU); 10 mi. NW Matanzas, 7550 ft, 5 (KU); 1 mi. NE Villa Hidalgo, 6550 ft, 5 (KU); 5½ *mi. N, 2 mi. W Guadalupe de Victoria, 7700 ft,* 1 (MSU); *8 mi. W Encarnación de Díaz, 6000 ft,* 2 (KU); 2 mi. SW Matanzas, 7550 ft, 13 (KU); Lagos, 1 (USNM). AGUASCALIENTES: *7 mi. N Rincón de Romos,* 1 (UNAM); 5 mi. NNE Rincón de Romos, 2 (KU); 3 mi. SW Aguascalientes, 6100 ft, 1 (KU). GUANAJUATO: 4 mi. N, 5 mi. W León, 7000 ft, 8 (KU). QUERETARO: Tequisquiapam, 12 (USNM).

Dipodomys phillipsii perotensis Merriam

1894. *Dipodomys perotensis* Merriam, Proc. Biol. Soc. Washington, 9:111, 21 June. Type locality—Perote, Veracruz.

1944. *Dipodomys phillipsii perotensis*, Davis, J. Mamm., 25:391, 21 December.

Distribution.—Known from Tlaxcala, a limited area in west-central Veracruz in the vicinity of the type locality, and from eastern Puebla (see Fig. 5).

Remarks.—From *D. p. phillipsii*, the subspecies *perotensis* is distinguishable by its somewhat longer cranium (see Table 3), narrower maxillary breadth and interorbital constriction, and paler dorsal coloration. Comparisons of *perotensis* with other subspecies are in the accounts of those taxa. Specimens from Tlaxcala (sample 11) are paler than specimens in the other two samples of *perotensis* studied, but in other respects the three samples are fairly homogeneous.

Merriam (1893:86–88), quoting from the field notes of E. W. Nelson, stated that southern banner-tailed kangaroo rats were known from the northern and eastern base of Cerro de Malinche and from San Marcos, both places in Tlaxcala, and several localities in Puebla including Cañada Morelos, Esperanza, San Juan de los Llanos, and Ojo de Agua. We have not seen specimens from any of these localities and it is unclear (except for the last-mentioned place) from the account whether Nelson had specimens in hand or simply based his notes on field observations. Nelson did see a specimen from Ojo de Agua, Puebla, in a small collection at a college in the city of Puebla.

Specimens examined (67).—TLAXCALA: Huamantla, 3 (USNM). VERACRUZ: 2 km N Perote, 8000 ft, 1 (KU); *2 km W Perote, 8000 ft*, 1 (KU); *Perote*, 7 (USNM); *2 km E Perote, 8300 ft*, 7 (KU); *Guadalupe Victoria* (*6 km SW Perote*), *8300 ft*, 5 (TCWC); *3 km W Limón, 7500 ft*, 3 (KU); *2 km W Limón, 7500 ft*, 4 (KU). PUEBLA: *Laguna Salada* (*near Alchichia*), *8000 ft*, 2 (TCWC); 2 km W Atenco de Aljojuca, 1 (UNAM); *10 km W Chalchicomula, 8300 ft*, 1 (TCWC); Chalchicomula, 31 (USNM); 7 mi. S, 3 mi. E Puebla, 6850 ft, 1 (KU).

Dipodomys phillipsii oaxacae Hooper

1947. *Dipodomys phillipsii oaxacae* Hooper, J. Mamm., 28:48, 17 February. Type locality—Teotitlán, 950 m, Oaxaca.

Distribution.—Known only from the type locality and one place in southern Puebla (see Fig. 5).

Remarks.—This subspecies is easily distinguished from all others of the species by its small size. Also, the color of *oaxacae* is much paler than that found in populations in adjacent areas of Puebla and Veracruz. Specimens we have examined exhibit the narrow maxillary (88.3 per cent) and interorbital (56.8 per cent) breadths relative to mastoid breadth that is characteristic also of *D. p. perotensis*.

D. p. oaxacae originally was described by Hooper (1947:48) on the basis of four specimens from Teotitlán, Oaxaca, until now the only known representatives of this distinctive subspecies. We have examined a specimen obtained by R. W. Dickerman at a place 1½ mi. W Tehuitzingo, Puebla, on 15 August 1954 that also appears assignable to *oaxacae* (this is the single individual in sample 15). This specimen is a young adult, but its appearance does not suggest that it ever will attain the size of the larger *perotensis*, which occurs to the northeast. We regard this specimen as only tentatively assigned to *oaxacae* until additional material becomes available from southern Puebla. It extends the known range of the subspecies approximately 130 kilometers to the west-northwest.

Specimens examined (5).—PUEBLA: 1½ mi. W Tehuitzingo, 3570 ft, 1 (KU). OAXACA: Teotitlán, 950 m, 4 (UMMZ).

NATURAL HISTORY

Habitat

Although there has been no extensive ecological study of the southern banner-tailed kangaroo rat, notes on natural history of the species have appeared in several publications (Merriam, 1893:88–89; Davis, 1944:391; Villa-R., 1953:404; Dalquest, 1953:117; Baker and Greer, 1962:103; Hall and Dalquest, 1963:282–283). The accounts of Merriam and of Hall and Dalquest are especially noteworthy and both contain descriptions of the burrows of *D. phillipsii.* Most of the accounts record these kangaroo rats as commonest on sandy soils in areas of short grass where large clumps of prickly pear or nopal cactus and low thornbrush are found. It is interesting to compare the record given by Merriam (*op. cit.*) of E. W. Nelson's field accounts, written in 1892 and 1893, in which it was noted that the species was abundant in the vicinity of Tlalpam in the Valley of Mexico, and that given by Villa-R. (*op. cit.*), written in the early 1950's, in which it was stated that the species was scarce in the vicinity of Tlalpam; in fact, Villa was unable to obtain specimens from that area. Authors agree that this kangaroo rat is extremely difficult to trap, possibly accounting for Villa's inability to obtain specimens, but an alternative is that the species may have been displaced from the vicinity of Tlalpam by urbanization.

In the following paragraphs, we have given brief descriptions of seven representative localities at which *D. phillipsii* was obtained by field parties from the Museum of Natural History and for which field notes are available. These portray the situations in which this species may be found and list other species of mammals that may be expected to be found in association with the southern banner-tailed kangaroo rat.

8 mi. SE Zacatecas, 7225 ft, Zacatecas.—R. H. Baker and a group of students visited this locality on 12–13 July 1952. Soils of the area are of volcanic origin and volcanic rocks were evident on the hills west of their campsite. Much of the land was under cultivation and many traps were placed along the edges of cornfields. Others were placed around clumps of grass and nopal cactus in a ravine near the camp. More than 190 mice were taken in 350 traps on the one night of trapping. Surprisingly, seven other species of heteromyid rodents were taken along with *Dipodomys phillipsii*—*Perognathus flavus, P. hispidus, P. nelsoni, Dipodomys merriami, D. ordii, D. spectabilis,* and *Liomys irroratus.* Other small mammals collected in this area included *Thomomys umbrinus, Reithrodontomys fulvescens, R. megalotis, Peromyscus maniculatus, P. melanophrys,* and *Neotoma albigula.*

La Mesa María de León, 7400 ft, Jalisco.—This locality, situated on a mesa approximately 1000 feet above the country immediately to the east, was visited from 21 to 24 June 1966 by P. L. Clifton and Genoways. The top of the mesa was a grassland supporting scattered oak trees, thus giving those areas not under cultivation a park-like appearance; the eastern edge of the mesa was steep and rock outcroppings were common there. Stands of trees and brush were much denser on the escarpment, with oak and manzanita being most abundant. Other species of mammals obtained at this place included *Didelphis marsupialis, Sylvilagus floridanus, Lepus callotis, Spermophilus mexicanus, S. variegatus, Perognathus flavus, Peromyscus boylii, P. maniculatus, P. melanophrys, Sigmodon hispidus, Neotoma albigula, Urocyon cinereoargenteus, Spilogale putorius,* and *Mephitis macroura.*

10 mi. NW Matanzas, 7550 ft, Jalisco.—P. L. Clifton described the area northwest of Matanzas in mid-May 1966 as consisting of thousands of acres of unbroken grassland, with scattered patches of nopal cactus. Low stands of oaks grew on small hills scattered through the area. Other mammals collected were *Sylvilagus floridanus, Lepus callotis, Spermophilus spilosoma, Thomomys umbrinus, Peromyscus difficilis, P. maniculatus, P. melanophrys, P. truei, Neotoma albigula, Canis latrans,* and *Spilogale putorius.*

TABLE 6.—*Distribution by month of capture of 220 southern banner-tailed kangaroo rats of three age classes.*

Month	Juvenile	Young	Adult	Total
January	—	—	—	—
February	1	1	1	3
March	—	—	—	—
April	0	1	30	31
May	2	5	11	18
June	2	4	33	39
July	1	2	28	31
August	0	1	6	7
September	3	2	11	16
October	1	1	16	18
November	0	2	6	8
December	15	10	24	49

2 mi. SW Matanzas, 7550 ft, Jalisco.—As the above locality, this place was essentially an unbroken prairie with scattered clumps of nopal cactus and thornbrush. Many traps were placed under clumps of nopal, which were surrounded by grass and weeds. The following species were obtained along with southern banner-tailed kangaroo rats on 13–14 October 1965: *Spermophilus spilosoma, Thomomys umbrinus, Perognathus flavus, P. hispidus, Peromyscus difficilis, P. maniculatus, Onychomys torridus, Sigmodon fulviventer,* and *Mephitis macroura.*

8 mi. W Encarnación de Díaz, 6000 ft, Jalisco.—Vegetation in this part of Jalisco was primarily grassland, scattered with mesquite and other thorny bushes. Some cultivation (mostly corn) also prevailed. Traps were set along the edge of a cornfield and among weeds along a rock fence. Mammals obtained in the period 6 to 10 October 1965 included *Sylvilagus audubonii, Spermophilus mexicanus, S. spilosoma, Perognathus flavus, P. hispidus, Dipodomys ordii, D. phillipsii, Reithrodontomys fulvescens,* and *Mus musculus.*

4 mi. N, 5 mi. W León, 7000 ft, Guanajuato.—This locality was visited by R. H. Baker and his field party shortly after they visited the locality in Zacatecas discussed above. The party camped on a grassy hillside where thornbrush and nopal cactus were abundant. There were numerous rock fences in the area along which many traps were set. Other rodents trapped at this locality included *Perognathus flavus, P. hispidus, Reithrodontomys fulvescens, Peromyscus maniculatus, P. melanophrys, P. truei,* and *Baiomys taylori.*

1½ mi. W Tehuitzingo, 3570 ft, Puebla.—Vegetation west of Tehuitzingo was dominated by mesquite; some areas were under cultivation with the fields planted mainly to corn. R. W. Dickerman, a field representative of the Museum of Natural History, trapped on 15 August 1954 along a sandy river bed and among brush on the dry slope above the river. Aside from a single specimen of *D. phillipsii,* the only other small mammal obtained there was *Liomys irroratus.*

Reproduction

Of 27 adult female southern banner-tailed kangaroo rats that were examined for reproductive data, only three were found to contain embryos. A female taken on 1 June 1954 at the southeast end of Laguna de Santiaguillo, Durango, carried two embryos that measured 25 in crown-rump length, and two females obtained on 25 October 1950 at a place 1 mi. NE Villa Hidalgo, Jalisco, each contained three embryos that measured 16 (KU 40014) and 24

(KU 40015) in crown-rump length. The remaining females, mostly collected in the months of June, July, and August, evinced no gross reproductive activity, and Hall and Dalquest (1963:283) reported that no females taken in Veracruz from late September to mid-November were pregnant. Length of testes for three adult males were 9 (3 June), 12 (23 June), and 11 (15 August).

Table 6 records 220 of the specimens we have examined by month of collection and by age. Only two months (January and March) are unrepresented by specimens. In only three months—April, August, and November—of the remaining 10 were no juveniles present in the sample and young individuals were present in all months. These data would seem to indicate a more prolonged reproductive period than can be deduced from the meager data on known reproduction in females.

Resumen

En un estudio de las ratas canguros del grupo *Dipodomys phillipsii*, se calcularon diversas variaciones geográficas y no geográficas. En la muestra proveniente de la vecindad de Perote, Veracruz, se reconocieron tres clases de edades (juveniles, subadultos, y adultos). En la muestra de Chalchicomula, Puebla, la variación estadística de los caracteres sexuales secundarios medidos fué poco significativa. Las variaciones geográficas de las medidas externas, craneales y del color del pelage fueron estudiados por medio de análisis de varianza y multivarianza para 15 muestras geográficas, las cuales revelaron que *Dipodomys ornatus* debe ser colocado como subespecie de *D. phillipsii*. Otras razas válidas son *phillipsii*, *perotensis*, y *oaxacae*.

Se incluye también algunas notas sobre la morfología del baculum, los lugares de vida y la reproducción de este grupo.

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